

# Crew Scheduling Performance



Crew Autonomy through Self-Scheduling: Guidelines for Crew Scheduling Performance Envelope and Mitigation Strategies

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# Current Team

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# Self-Scheduling Enables Crew Autonomy

## BENEFITS

Enables crew to contribute their insight how to best manage schedule.

Minimizes idle time waiting for Mission Control responses.

Mitigates effects of communication latency, intermittent communication, and limited bandwidth.

## CHALLENGES

Different concept of operations that requires new protocols.

Do not want to overwhelm astronauts who are not expert mission planners.

Still need to ensure and retain constraint-abiding plans and schedules.

# Research Objective

Characterize the human performance envelope for the task of planning and scheduling (crew self-scheduling), develop countermeasures to mitigate adverse performance effects due to plan complexity, and inform performance standards and guidelines based on research results.



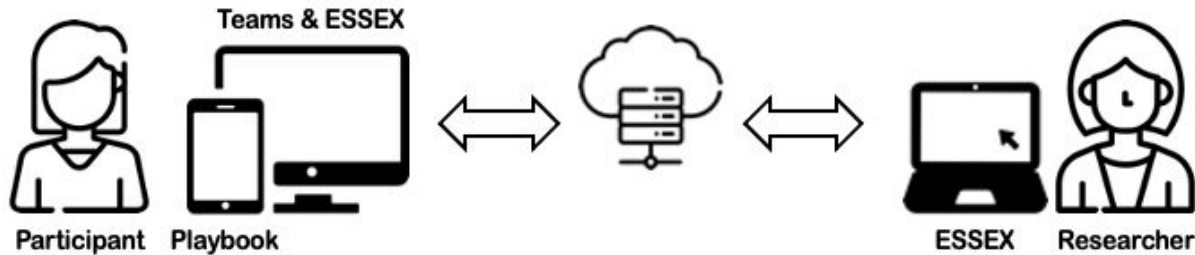
# Research Aims

1. Quantify crew performance envelope for the task of self-scheduling spaceflight operational plans.
2. Develop countermeasures that mitigate deficient crew self-scheduling performance.
3. Validate self-scheduling countermeasures by evaluating changes in crew performance with countermeasures in spaceflight analogs.
4. Recommend standards and guidelines appropriate for autonomous crew in long duration exploration missions with regards to self-scheduling.

# Remote Data Collection

## YEAR 2: “Big” Experiment

- Conducted a completely remote, human-in-the-loop experiments in Year 2, leveraging experimental platform (ESSEX) and Playbook.
- Collect self-scheduling human performance data from 31 participants.



# Human Performance of Self-Scheduling

Mixed factorial design (2 x 2 x 4)

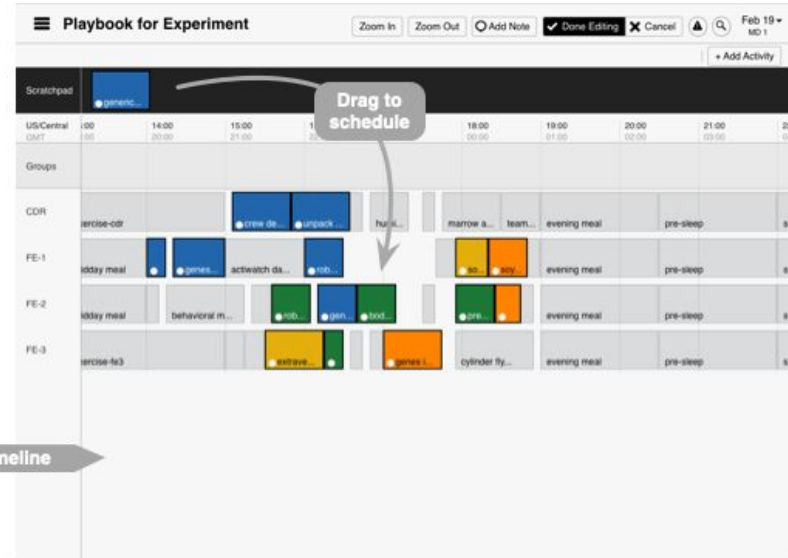
- One between-subject factor: type of task (scheduling vs. rescheduling)
- Two within-subject factors:
  - Percent of activities with constraints ( $\frac{1}{3}$  vs.  $\frac{2}{3}$ )
  - Type of activity constraints (equality requirement, earliest/latest, claimables, and temporal binary constraints)

Dependent measures include: effectiveness, efficiency, situation awareness, workload, trust, and usability.

# Self-Scheduling Task

Activity Name	Notes	Due Date
30 minutes FE-2 Scheduled Feb 19 18:10	gene...	
✓ Genes in Space MWA Preparation 15 minutes FE-3 Scheduled Feb 19 18:15	Must start no earlier than 12:00 Medium Priority	Due by 2/19/19
✓ Generic Frozen Blood Sample Set up 45 minutes FE-1 In Scratchpad.	Medium Priority	Due by 2/19/19
✓ Body Sampling Survey 30 minutes FE-2 Scheduled Feb 19 18:40	Low Priority	Due by 2/19/19
✓ Genes in Space MELFI Sample Retrieval 45 minutes FE-3 Scheduled Feb 19 17:00	High Priority	Due by 2/19/19
✓ Pre-sleep questionnaire 30 minutes FE-2 Scheduled Feb 19 17:35	Low Priority	Due by 2/19/19

Task List activities have priorities and some have constraints.



Activities are scheduled and assigned to complete a violation-free timeline.

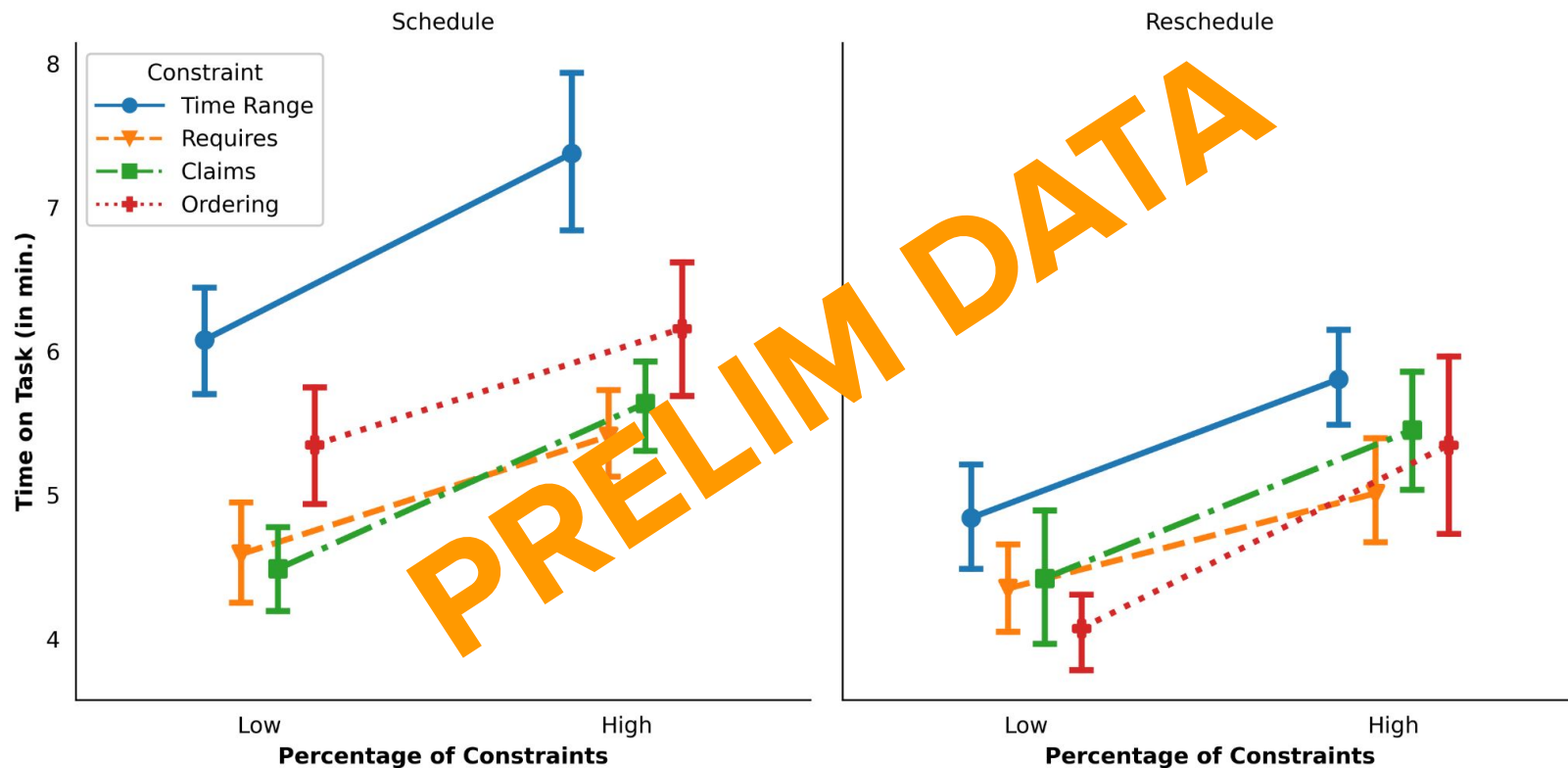


# Results

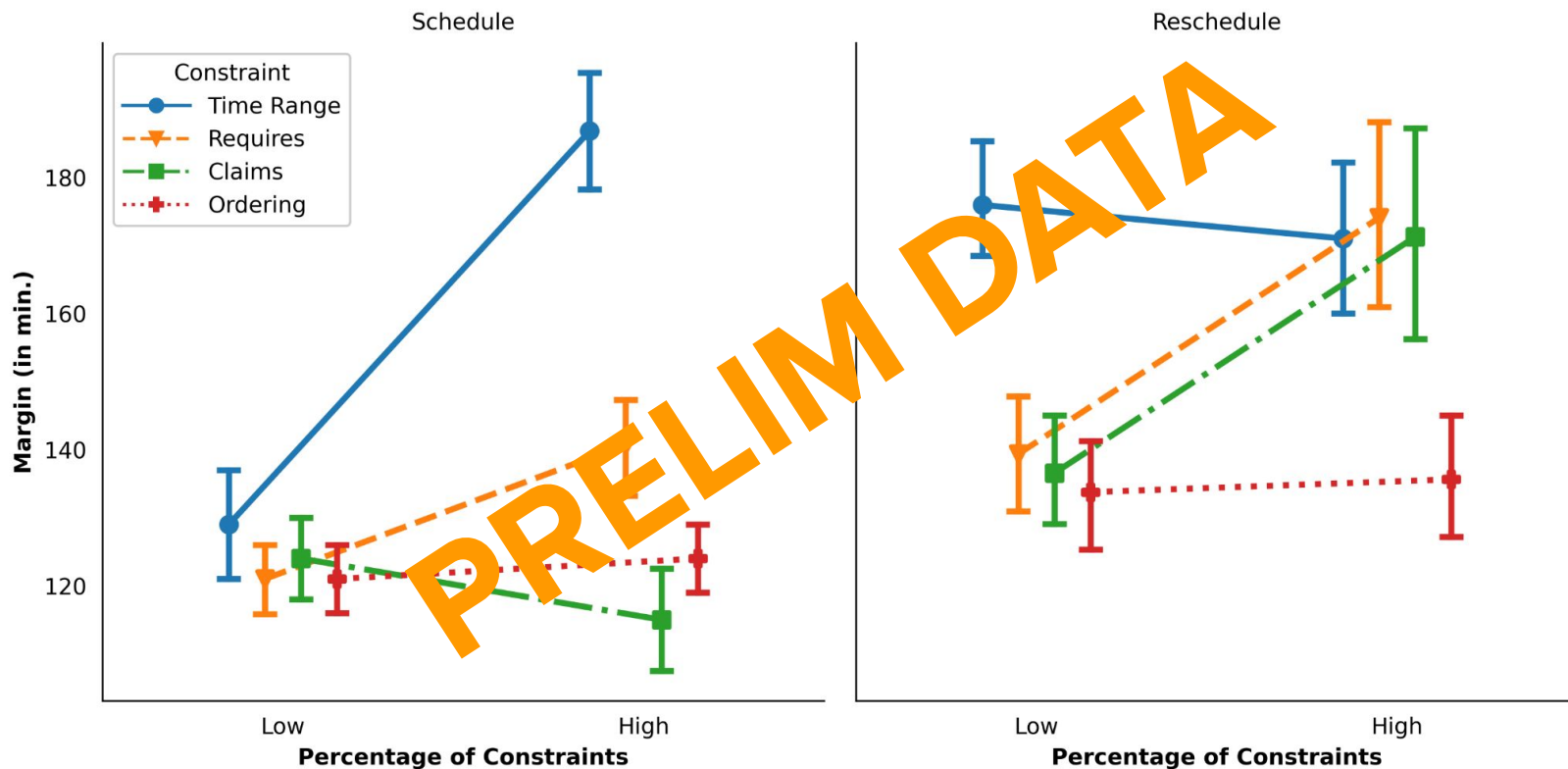
## YEAR 3: Data Analysis & Publications

- Main Results
  - Significant effects of type of task, type and number of constraints
  - Scheduling is *generally* "harder" than rescheduling
  - More constraints are *generally* "harder" than less constraints
- Constraints affect different metrics uniquely
  - Time Range (TR) constraint takes much longer for participants to resolve
  - Claimables (CL) constraints result in more violations
- Significant interaction effects show that the story is complicated
- 1 journal publication, 5 conference papers, and 1 upcoming conference paper

# Time on Task



# Margin (white space)



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# Designs of New Countermeasures

≡ Playbook

↑ Add Note

✓ Done Editing

✕ Cancel

⚠

🔍

📅 Jan 7 | MD1

⋮

+ Add to Plan

Scratchpad

US/Central GMT	07:00 12:00	08:00 13:00	09:00 14:00	10:00 15:00	11:00 16:00	12:00 17:00
Comm	<div></div>					
Groups						
EV1	<div>● activity a</div>					
EV2	<div>● activity b</div>					
IV						
Other-1						
Other-2						
Other-3						
Other-4						

EV1

✕

Activity A

09:30 to 10:30 (30m) | EV1

⚠ Activity A must start no earlier than 1 hour after Activity B ends (which is at 08:50)

This is an execution note.

13. This is an indented execution note.

14. Pre-stage short wire tie on PMA3 TA-Clamp C5

15. Retrieve BLUE cable P203 (W2256) from NOD2 HR 326 (Note: P208 leg of W2256 cable will be routed to aft [

16. Route BLUE cable (W2256):

a. Route under fwd/port CBM petal

b. Secure with PMA3 TA-Clamp C5

This is an operations note. These notes are for operations things.

[101.1\\_Procedure.pdf](#)

[101.2\\_Procedure.pdf](#)

Start Progress

Details...

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# HERA Campaign 6

## YEAR 3: Validation in Analog Environment

- HERA C6
  - Each crewmember gets to self-schedule one mission day for the 4-person crew.
  - Focusing on evaluating countermeasure aids: M1 & M2 (no aids) vs. M3 & M4 (with aids).
  - Taking advantage of the opportunity that crew is allowed to self-schedule throughout most of the mission to collect additional operational-relevant self-scheduling data.
  - Established data sharing agreements with BHP Lab & other HFBP grants in HERA.
- Upcoming work
  - Continued data collection for M2 through M4. Post-processing HERA data.
  - Assessing additional opportunity for NEEMO analog and HERA Campaign 7.

# Human Performance of Self-Scheduling

Next steps:

- Finish summarizing findings, through reports and publications.
- Continued data collection in analogs.
- Begin summarizing recommended standards and guidelines.



**Questions?**

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